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Patentanmeldung Nr. Patent application No. Demande de brevet n°

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Blatt 2 der Bescheinigung
Sh et 2 of the certificate
Page 2 de l'attestation

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Titre de l'invention:
Welded microfilter tube comprising sintered fibers

In Anspruch genommene Priorität(en) / Priority(ies) claimed / Priorité(s) revendiquée(s)

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Field of th invention.

The present invention relates to a filtering tube comprising one or more layers of a presintered web of steel fibers. The present invention particularly relates to a cross-flow filtering tube with microfiltration characteristics, i.e. with a filter rating equal to or below 20 micrometer, preferably below 10 micrometer.

A "cross-flow filtering tube" refers to a filtering tube where the incoming fluid enters axially the tube, where the non filtered fluid exits axially the tube and where the filtered fluid exits radially the tube.

Background of the invention.

Filtering tubes having as filtering medium a sintered web of steel fibers is known in the art. US-A-3,505,038 discloses a tubular filter medium where the filter medium is mainly formed by compacted mat of steel fibers. The tubular filter medium is made by spirally wrapping a steel fiber mat around an inner cylinder of a woven wire screening mesh to form a tube. The mat and the mesh are consolidated with pressure and sintered into a compact body. The fiber mat performs the major filtration work while the inner screen functions as a safety factor. The fiber mat can be spotwelded to the inner screen.

Such an embodiment, however, presents several disadvantages.

A first disadvantage is that, due to the presence of the inner screen, it is difficult to decrease the inner diameter of such tubular structure to below a value where the pump and energy costs required to have the structure function as a cross-flow filter remain below acceptable levels. It is hereby understood that the greater the inner diameter the greater the required pump and energy costs are.

A second disadvantage is that such tubular structures are not adapted for microfiltration. Indeed, in order to reach a filter rating below 20 micrometer or even below 10 micrometer the mat of fibers needs to b compacted to such a degree that connecting the mat to a tubular structure causes a lot of t chnical problems.

Summary of the invention.

It is an object of the present invention to avoid the disadvantages of the prior art.

It is another object of the present invention to provide a tubular filtering structure with a filter rating below 10 micrometer.

It is yet another object of the present invention to make it possible to decrease the internal diameter of the tubular filtering structure.

According to the invention there is provided a filtering tube with one or more layers of a presintered web of steel fibers. The steel fibers have a diameter smaller than 8 micrometer. The layers are preshaped so as to form easily the tube form. The layers overlap with each other and form an overlapping zone, which may run substantially parallel to the axis of the tube. The overlapping zone is compacted and a continuous resistance weld is created in the overlapping zone.

The term continuous weld is used here to make a distinction with spot welding. With resistance welding it has been possible to make a tubular filter where the greatest pore sizes, as experienced during a standard bubble point test, all lie outside the overlapping or welding zone. Indeed, resistance welding is preferred over other ways of welding, since with resistance welding it is possible to tune and control the amount of electrical input energy so that melting of the very thin fibers is avoided. Also partially melting of the fiber layers has to be avoided as much as possible since melting causes shrinkage and shrinkage may cause cracks and creation of pores with an unacceptable large pore size larg r than the original pore size.

The invention does not exclude a tube with a supplemental layer of a presintered web of steel fibers with a diameter greater than 8 µm where this supplemental layer functions as a support layer.

Preferably at least one of the layers of the presintered web has a porosity greater than 70%.

By a suitable choice of fiber diameters, of the compacting degree and of the way of compacting, filter ratings below 20 micrometer and even below 10 micrometer can be obtained.
The smaller the fiber diameter and the greater the compacting degree the smaller the obtained filter rating. However, as mentioned above, the degree of compacting is limited.
For obtaining filter ratings which are below 5 micrometer and are down to 0.5 micrometer, two or more layers of a fiber web are used. One, relatively thin, highly compacted presintered layer with a small fiber diameter (e.g. 1 µm or 2 µm) and a porosity smaller than 65%, e.g. smaller than 55%, and is combined with another thicker layer which has a porosity higher than 70%, e.g. higher than 80%. The first thin compact layer determines the filter rating while the second relatively thick and highly porous layer functions as a support buffer for the first thin layer during welding and allows for the further compacting in a welding zone during the welding operation.
Preferably the thin layer with a porosity lower than 65% is isostatically pressed. Isostatically pressing allows to obtain a homogeneous filter medium where a low filter rating is combined with a porosity which is as high as possible.

In order to allow for suitable welding the preshaped and presintered layers overlap with each other and form an overlapping zone.

The welded tube can be sintered afterwards. An advantage of this sintering is that the tube is straightened and that stresses are eliminated. Stress corrosion is avoided in this way.

In a preferable embodiment of the invention and in order to decrease further pump and energy costs, a central rod with a diameter smaller than the internal diameter of the tube, is put in the filtering tube so that the available cross-section is substantially decreased. As the cross-section is proportional the fluid flow and as the pump and energy costs decrease exponentially with decreasing amount of flows, the savings in pump and energy costs can be substantially high.

As a preferred alternative to a central rod, a central vortex or worm can be used. Such a vortex or worm has as a supplementary advantage that it creates many local turbulences in the flow of the fluid. These turbulences may clean the surface of the filter so that cleaning can be postponed and so that the permeate flux remains at a high level during a longer time.

A filtering tube can have at its ends caps in order to facilitate the mounting in a more complex filter structure. Such caps can be made in stainless steel or in a plastic material such as a suitable epoxy. Stainless steel caps are TIG-welded to the filtering tube.

Filtering tubes according to the invention can be used for the filtration of fluids such as waste waters, oils, ...

Brief description of the drawings.

The invention will now be described into more detail with reference to the accompanying drawings wherein

- FIGURE 1 shows a side view of a filtering tube according to th invention ;
- FIGURE 2 shows how filtering tubes can be built in a larger entity ;

- FIGURE 3 shows a cross-section of a two-layered web of steel fibers ;
- FIGURE 4a shows a cross-section of an overlapping zone of a filtering tube before welding ;
- FIGURE 4b shows how welding is done at the overlapping zone ;
- FIGURE 4c shows a cross-section of an overlapping zone of a filtering tube after welding ;
- FIGURE 5 shows a transversal cross-section of a filtering tube with a central rod inside ;
- FIGURE 6 shows a longitudinal cross-section of a filtering tub with a central vortex inside.

Description of the preferred embodiments of the invention.

FIGURE 1 shows a side view of a filtering tube 10 according to the invention. The filtering tube 10 comprises a cylindrical body 12 which mainly consists of a presintered and preshaped web of steel fibers. A supporting wire screen is not required. The internal diameter of cylindrical body ranges from 8 mm to 200 mm, e.g. from 8 mm to 50 mm. The filtering tube may have a length from 500 mm to 1500 mm, e.g. from 500 mm to 1000 mm. The filtering tube 10 has end caps 14 at both ends. These end caps 14 can be in stainless steel or in a suitable epoxy resin. If the end caps 14 are in steel, they are welded to the tube 10. If the end caps 14 are in epoxy, they are cast to tube 10. The cylindrical body 12 shows a continuous welding line 16 along its length.

The filtering tube is adapted to function in cross-flow mode. This means that the incoming fluid enters axially, as designated by arrow 18. The filtered fluid exits radially (= arrows 20). The non-filtered fluid exits axially (= arrow 22). This non-filtered fluid may be repumped to nt r again the same tube.

FIGURE 2 illustrates how a number of filtering tubes 10 can be built in a more complex filter structure 24. The filter structure 24 comprises end flanges 26 at both ends. The filtering tubes 10 are fixed in these end flanges 26 by means of O-rings or by means of an epoxy 28. The filtering structure 24 is provided with outlet openings 30 to allow to discharge the filtered fluid.

FIGURE 3 illustrates a double layered web 32 of steel fibers. A layer 34 of steel fibers with a diameter of e.g. 2 µm is presintered and highly compacted, e.g. by means of cold isostatic pressing, to a porosity below 65% and to a thickness of e.g. 0.20 mm. A second layer 36 of a non-woven web of steel fibers with a thicker diameter, e.g. 6.5 µm, is sintered and compacted to the first layer 34. The porosity of the second layer 36 remains above 70%, e.g. above 80%, in order to allow subsequent compacting in the overlapping zone during the welding operation. The thickness of the compacted second layer is e.g. 0.40 mm so that the total thickness of the two-layered web is 0.60 mm.
The flat two-layered web is preshaped and subsequently formed into a cylindrical form with an overlapping zone 38, as illustrated in FIGURE 4a. The non-welded cylindrical form is then shifted over a copper bar 42. FIGURE 4b shows how a continuous resistance weld 43 is formed in the overlapping zone by means of a resistance wheel 44. During this resistance welding the resistance wheel 44 compacts the web to such a degree that the double thickness in the overlapping zone is reduced to approximately a single thickness at the resistance weld 43. This compacting is made possible by the highly porous nature (above 70%) of at least one of the layers of the web of steel fibers. FIGURE 4c illustrates the overlapping zone 38 after the welding operation.

If a filtering tub 10 according to the invention is properly welded and if it is submitted to a bubble point test after welding, it must show the first

bubbles coming out in zones outside the welding zone, which means that the greatest pore sizes must lie outside the welding zone.

The welded filtering tube 10 can be sintered again to eliminate stresses and straighten the tube. It has been experienced that the filtering tubes can withstand a pressure of at least 4 bar from the outside to the inside.

FIGURE 5 shows a transversal cross-section of an advantageous embodiment of the invention. A cylindrical rod 46 is put centrally in th cylindrical body 12. This is done to reduce the cross-section surface so that the amount of fluid output is reduced and so are the pump and energy costs.

In a preferred embodiment of the invention, a vortex 48 is located centrally in the cylindrical body 12, as is shown in FIGURE 6. This vortex 48 has the same effect of the cylindrical rod 46 in FIGURE 5 : Reduction of the available surface to reduce the fluid output and the required pump and energy costs. However, in addition to this advantage, the form of the vortex 48 creates many local turbulences which may prevent particle material from gathering at the inner surface of the filter.

CLAIMS

1. A cross-flow filtering tube (10) comprising one or more layers (34, 36) of a presintered web of steel fibers, characterized in that said steel fibers have a diameter smaller than 8 µm, in that said layers are preshaped, said layers overlapping with each other forming an overlapping zone (38), said overlapping zone comprising a continuous resistance weld (16).

2. A tube according to claim 1 wherein said tube has filter rating less than 20 micrometer.

3. A tube according to any one of the preceding claims wherein said tube has an internal diameter ranging from 8 mm to 200 mm.

4. A tube according to any one of the preceding claims wherein at least one of said layers has a porosity greater than 70 %.

5. A tube according to any one of claims 2 to 4 wherein said tube comprises two layers, one of said layers having a porosity smaller than 65 %.

6. A tube according to claim 5 wherein said layer with a porosity small r than 65 % has been cold isostatically pressed.

7. A tube according to any one of the preceding claims wherein the greatest pore sizes lie outside said overlapping zone.

8. A tube according to any one of the preceding claims wherein said tube has been sintered.

9. A tube according to any one of the preceding claims said tube comprising a central rod with a diameter smaller than the internal diameter of said tube.

10. A tube according to any one of claims 1 to 8, said tube comprising a central vortex or worm with a diameter smaller than the internal diameter of said tube.

11. A tube according to any one of the preceding claims wherein said tube comprises a stainless steel end cap.

12. A tube according to any one of claims 1 to 10 wherein said tube comprises an end cap made of a plastic material.

13. A tube according to any one of the preceding claims wherein said tube further comprises a supplemental layer of a presintered web of steel fibers with a diameter greater than 8 µm, said supplemental layer functioning as a support layer.

ABSTRACT :

A cross-flow filtering tube (10) comprises one or more layers (34, 36) of a presintered web of steel fibers. These steel fibers have a diameter smaller than 8 µm. The layers are preshaped. The layers overlap with each other and form an overlapping zone (38). The overlapping zone comprising a continuous resistance weld (16).

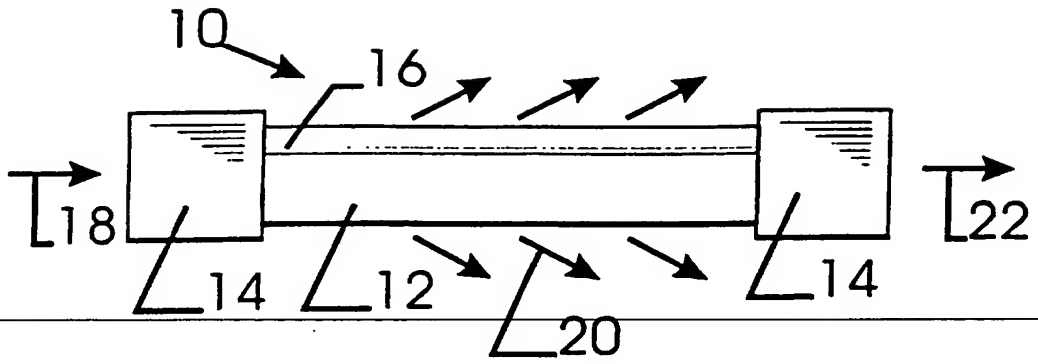

Fig. 1

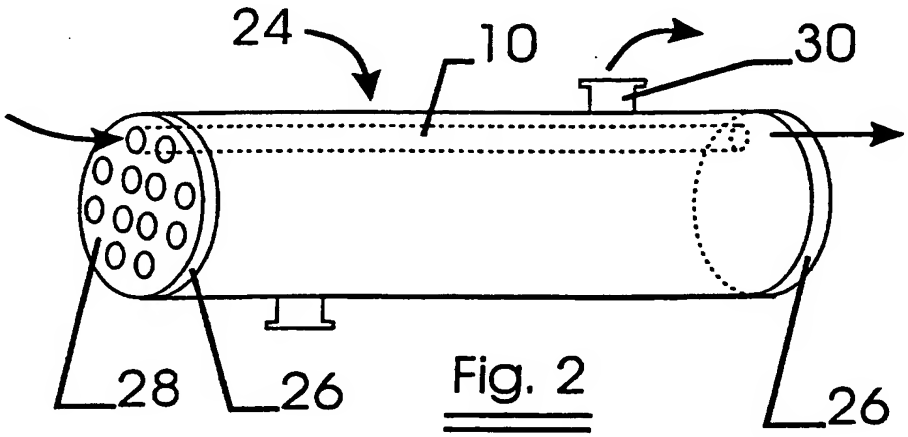

Fig. 2

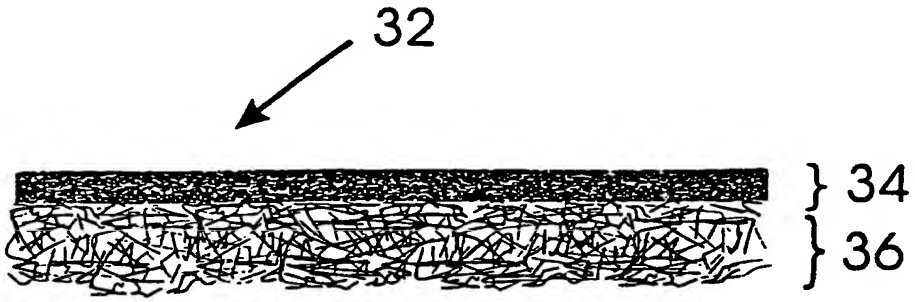

Fig. 3

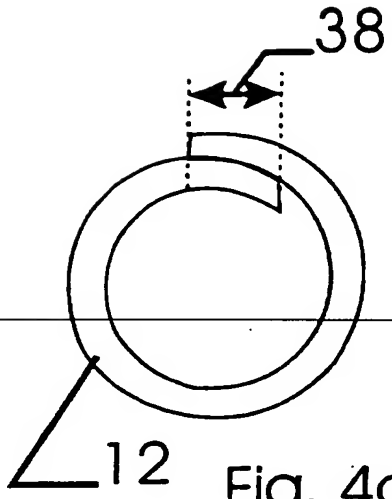

Fig. 4a

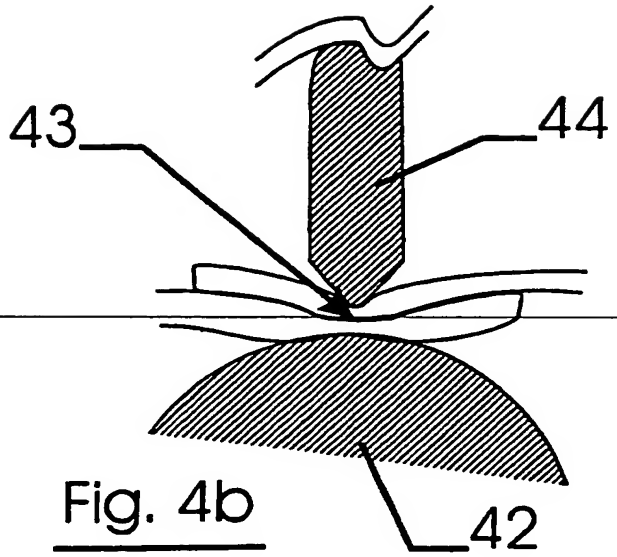

Fig. 4b

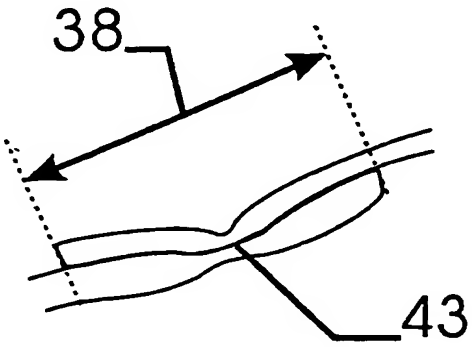

Fig. 4c

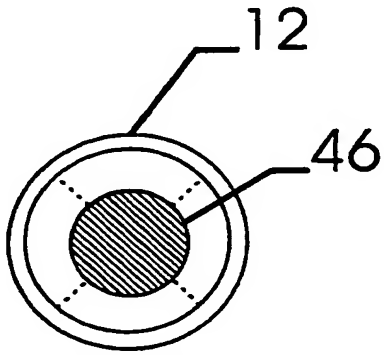

Fig. 5

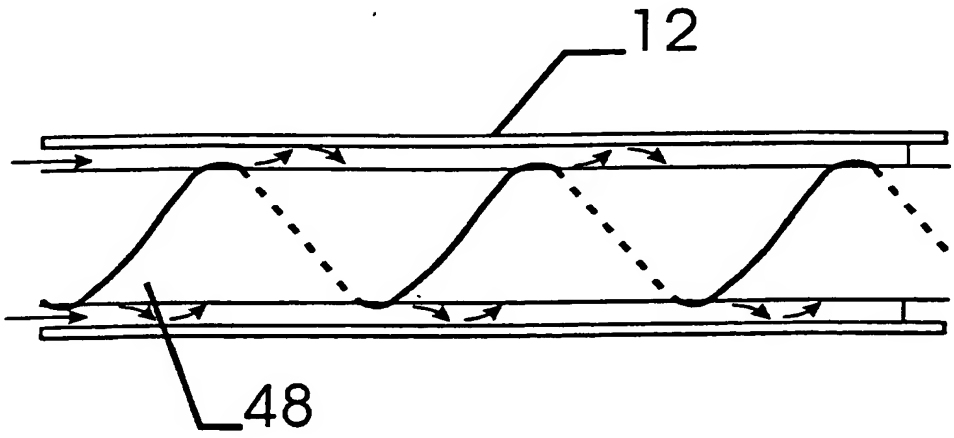

Fig. 6